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ORGANOSILICATE POLYMER AND LOW-DIELECTRIC-CONSTANT DIELECTRIC
MEMBRANE CONTAINING SAME

[Yugi-sillikeiteu junghapche mit i-reul hamyu-haneun jeoyujeon jeoryeonmak]

Min-jin Go et al.

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INVENTORS	(72):	Min-jin Go et al.
APPLICANT	(71):	LG Chemicals, Ltd.
PATENTEES	(73):	Jae-man Kim Song et al.
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Specification

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Detailed explanation of the Invention

Objective of the invention

Art of the invention and prior art of the field

The present invention pertains to an organosilicate polymer, and specifically to a durable and thermally stable organosilicate polymer and a preparation for a dielectric membrane for use in a semiconductor element, and a dielectric applying said preparation, and a method for producing said dielectric.

As the degree of integration of semiconductor elements continues to increase, the width of the conducting wires that connect the interior of the element is dropping rapidly; around 2003, it is expected that high-density elements will be developed using circuit wires with a width of 0.1 μm . In general, the speed of semiconductor elements is proportional to the transistor switching speed and the signal transmission speed; the signal transmission speed is determined by the RC delay, represented by the product of the resistance of the wire and the capacitance of the interlayer dielectric membrane. As the degree of integration increases, the distance between the metal wires that connect the interior of the element is reduced, and, at the same time that the wires become thinner, their length increases in geometric progression; thus, the speed on a high-density chip is determined less by the switching speed

* [Numbers in right margin indicate pagination of the original text.]

than by the RC delay on the high-density chip. Therefore, in order to produce high-speed chips, conductors with a low resistance and dielectric materials with a low dielectric coefficient must be used. In addition, the use of low-K substances has the advantage of not only increasing the speed of the semiconductor elements, but also reducing electricity consumption and markedly reducing cross-talk phenomena between the wires.

IBM recently released a prototype that does not use the previous aluminum wires, but, rather, uses copper wires with high electrical conductivity for an increase in performance of 30% or more. On the other hand, semiconductor elements that employ low-K materials suffer from difficulties in commercialization, due to the inadequate development of suitable materials.

The interlayer dielectric material used in semiconductor elements such as IC, LSI, etc., has primarily been SiO_2 with a dielectric constant of 4.0; silicate doped with fluorine (F-SiO_2) is used in some elements. However, when the fluorine component of F-SiO_2 reaches 6%, it becomes thermally unstable, making it difficult to reduce the dielectric constant below 3.5. Recently various thermally stable low-polarity organic and inorganic polymers have been suggested in order to solve these problems.

Organic polymers with a low K or dielectric constant are known to include polyimide resin, polyarylene ether resin, and perfluorocyclobutane-containing resin, either with or without fluorine doping. Most of these organic polymers have dielectric constants of 3.0 or less, but in general, because their glass transition temperature is low, they have low moduli of elasticity at high temperatures, and

their coefficient of linear thermal expansion is very high. In addition, organic polymers containing fluorine are even more burdened by these problems. Semiconductor production and packaging processes can reach high temperatures of 200 to 450°C. Therefore, it is possible that organic polymers with low thermal stability and elasticity, and high coefficients of linear thermal expansion, will reduce the reliability of the elements or circuit boards.

In order to resolve the above-described thermal stability problems of organic polymers, an organosilicate polymer that uses a sol-gel process is currently under development. This method forms an organosilicate membrane through the hydrolysis and condensation of organosilane followed by a drying process. By this method, silsesquioxane has a low dielectric coefficient of 3.0 or less and is thermally stable at 450°C. However, the aforementioned organosilicate polymer produced as described has a very high degree of compressive stress, and therefore cracks can readily appear with a width of 1 μm or more, and the mechanical strength is reduced through the addition of alkyl groups; in addition, unreacted functional groups sometimes remain after the final drying. /3

Technical field of the invention

The objective of the present invention is to provide a low-K substance, with due consideration for the aforementioned problems of the prior art, which is capable of accelerating semiconductor element speed

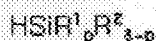
and reducing power consumption and can be used as an interlayer dielectric membrane for super-low-K circuits that can dramatically reduce the crosstalk phenomena between metal wires.

An additional objective of the present invention is to provide a silica polymer having good membrane characteristics and excellent mechanical and dielectric characteristics, as well as a method for producing the same, in addition to a dielectric membrane containing this polymer and a method for producing the same.

Configuration and action of the invention

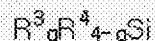
In order to achieve the above-described objectives, in terms of an organosilicate polymer, the present invention provides a) 1 or more hydride silane compounds as shown in Chemical Formula 1 below, and b) 1 or more chosen from the group comprising compounds shown in Chemical Formula 2 below, compounds shown in Chemical Formula 3 below, and compounds shown in Chemical Formula 4 below:

[Chemical Formula 1]



In Chemical Formula 1 above, R^1 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^2 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; p is a constant from 0 to 2.

[Chemical Formula 2]



In Chemical Formula 2 above, R^3 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^4 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; q is a constant from 0 to 3.

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[Chemical Formula 3]



In Chemical Formula 3 above, R^5 and R^7 are each independently a hydrogen, aryl, vinyl, allyl, or a 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^6 and R^8 are each independently a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; r and s are constants from 0 to 2.

[Chemical Formula 4]



In Chemical Formula 4 above, R^9 is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{10} is



and the R^{11} of R^{10} here is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{12} is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; a is a constant from 1 to 6, and b is a constant from 0 to 2; n and m are each independently constants from 0 to 10.

In addition, the present invention provides a method for producing an organosilicate polymer comprising a) a stage at which i) 1 or more of the hydride silane compounds shown in Chemical Formula 1 above, together with ii) 1 or more silane compounds chosen from the group comprising the compounds shown in Chemical Formula 2, the compounds shown in Chemical Formula 3, and the compounds shown in Chemical Formula 4, are mixed together in an organic solvent; and b) a stage at which catalyst and water are added to said mixture and hydrolysis and condensation reactions are carried out. /5

In addition, the present invention provides a preparation for a dielectric membrane including a) i) 1 or more hydride silane compounds as shown in Chemical Formula 1; and ii) an organosilicate polymer derived from the hydrolysis and condensation of 1 or more silane compounds chosen from the group comprising the compounds shown in Chemical Formula 2, the compounds shown in Chemical Formula 3, and the compounds shown in Chemical Formula 4; and b) an organic solvent.

In addition, said dielectric membrane preparation may contain c) 1 or more additives suitable to the objective, chosen from among organic molecules, organic polymers, organic dendrimers, colloidal silica, aerosols, geosols, and surfactants.

In addition, the present invention provides a method for producing a dielectric membrane for use in semiconductor elements including a) a stage wherein a preparation in solution is provided comprising i) α) one or more hydride silane compounds as shown in Chemical Formula 1 above; and β) an organosilicate polymer derived from the hydrolysis and condensation of one or more silane compounds chosen from the compounds shown in Chemical Formula 2, the compounds shown in Chemical Formula 3, and the compounds shown in Chemical Formula 4; and ii) an organic solvent, and iii) if necessary, 1 or more additives chosen from among organic molecules, organic polymers, organic dendrimers, colloidal silica, aerosols, geosols, and surfactants; b) a stage wherein a dielectric membrane is formed by coating the base material of the semiconductor element with the solution from stage a); c) a stage wherein the dielectric membrane formed in stage b) is dried and shaped; and d) if necessary a stage wherein the aforementioned is dielectric membrane is subjected to surface processing.

Hereinbelow, the present invention is described in greater detail.

The present invention provides, as the organosilicate polymer, a hydrolyzed condensate formed through the mixture is a specific ratio of 1 or more of the hydride silane compounds shown in Chemical Formula 1, and 1 or more silane compounds chosen from the group comprising the compounds shown in

Chemical Formula 2, the compounds shown in Chemical Formula 3, and the compounds shown in Chemical Formula 4; a method for producing the same; a preparation for the formation of a membrane containing same; an organosilicate polymer interlayer dielectric membrane produced through the copolymerization of said preparation; and a method for producing same.

The organosilicate polymer of the present invention, if applied to a dielectric polymer, shows low-dielectric-constant properties and has excellent mechanical properties.

The hydride silane compound of Chemical Formula 1 above in this invention, and the silane compound selected from the group comprising the silane compounds shown in Chemical Formulas 2, 3, and 4 above, are added to water and catalyst in the presence of a solvent and hydrolysis and condensation reactions are induced, so that an organosilicate polymer of a certain molecular weight is obtained and the preparation for a dielectric membrane is obtained. There are no particular restrictions on the sequence in which the hydride silane compound of Chemical Formula 1 above and the silane compound selected from the group comprising the silane compounds shown in Chemical Formulas 2, 3, and 4 above are mixed together. In other words, the hydrolysis/condensation reaction may be carried out after the entire amount to be used has been mixed together, but it is also acceptable to first carry out hydrolysis and condensation of a certain fraction of the total amount, bring it to the desired molecular weight, and then add the remainder and react.

The quantity of the hydride silane compound shown in Chemical Formula 1 to be used is mixed in a proportion such that the ratio of hydrogen atoms attached to one mol of silicon atoms in all silane compounds used is between 0.001 and 0.5 mol, preferably between 0.005 and 0.2 mol.

In the production of the aforementioned organosilicate polymer, if compounds are used corresponding to those shown in Chemical Formula 2 above having a value of q of 2 or 3, this should preferably be less than 70 wt% of the total silane compounds, and preferably less than 40%. Quantities greater than this may reduce membrane strength.

The solvent used in the polymerization and in the preparation for use in forming a dielectric membrane may, for example, be an aliphatic hydrocarbon solvent such as *n*-pentane, *i*-pentane, *n*-hexane, *i*-hexane, 2,2,4-trimethylpentane, cyclohexane, or methycyclohexane; an aromatic hydrocarbon solvent such as benzene, toluene, xylene, trimethylbenzene, ethylbenzene, or methylethylbenzene; an alcohol solvent such as methyl alcohol, ethyl alcohol, *n*-propanol, *i*-propanol, *n*-butanol, *i*-butanol, *sec*-butanol, *t*-butanol, cyclohexanol, methylcyclohexanol, or glycerol; an ester solvent such as tetrahydrofuran, 2-methyl tetrahydrofuran, ethyl ether, *n*-propyl ether, isopropyl ether, diglyme, dioxin, dimethyl dioxin, ethylene glycol monomethylether, ethylene glycol dimethyl ether, ethylene glycol diethyl ether, propylene glycol monomethyl ether, or propylene glycol dimethyl ether or an amide solvent such as *N*-methyl pyrrolidone, formamide, *N*-methyl formamide, *N*-ethyl formamide, *N,N*-dimethyl acetamide, or *N,N*-diethyl acetamide.

The solvent that is used in the hydrolysis and condensation reaction is entirely removed after the reaction, and a polymeric organosilicate oil or powder is obtained; this organosilicate powder can either be dissolved again in an organic solvent to form a membrane, or used directly for membrane formation after a specific quantity of the solvent which may have a deleterious effect on the coating properties is removed from the organic solvent used in the hydrolysis and condensation reaction. The aforementioned organic solvents can be either 1 type, or 2 or more types used together in a mixture.

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In this invention, it is preferable that a catalyst be used to promote the hydrolysis/condensation reaction. The catalyst used in the hydrolysis/condensation reaction may be an acid catalyst, base catalyst, or metal-chelate compound; an acid catalyst is ideal. For example, acid catalysts that can be used include hydrochloric acid, nitric acid, sulfuric acid, phosphoric acid, formic acid, benzenesulfonic acid, toluenesulfonic acid, acetic acid, oxalic acid, malonic acid, maleic acid, fumaric acid, citric acid, and propionic acid; base catalysts that can be used include ammonia, sodium hydroxide, potassium hydroxide, calcium hydroxide, trimethylamine, diethanolamine, triethanolamine, dimethylethyl alcohol amine, monomethyl diethanol amine, diazabicycloundecene, pyridine, pyrrolpiperidine, choline, pyrrolidine, and piperazine. Metal chelate compounds include organometal compounds with aluminum, titanium, zirconium, tin, or tantalum, etc., as the metal. The aforementioned acids, bases, and metal-chelate compounds can be used either singly or in combination. Also, 2 or more kinds can be used in sequence.

The quantities of catalyst added may be from 0.0001 to 1 mol per mol of total silane compounds; preferably this should be 0.5 or less. If the quantity of catalyst exceeds 1 mol per 1 mol of silane compounds, the reaction speed becomes very high, making the molecular weight difficult to control, and readily causing gel formation.

In the present invention, water is added for the hydrolysis of the silane compounds. The appropriate quantity of water for hydrolysis of the silane compounds may be from 0.1 to 20 mol per 1 mol of silicon atoms in the total quantity of silane compounds used; preferably this should be between 1 and 10 mol. The water can be added either all at once or gradually. At this point, the catalyst may already have been added to the organic solvent, or may be dissolved or dispersed when the water is added. At this point, with regard to the reaction temperature, the reaction is normally carried out at between 0 and 100°C, and preferably between 15 and 80°C. The average molecular weight of the hydrolyzed condensate thus obtained is ordinarily between 500 and 1,000,000, preferably between 1000 and 1,000,000.

In the membrane formation preparation obtained through this invention, specific quantities of organic molecules, organic polymers, and dendrimers can be added to further reduce the density of the dielectric membrane. The type of organic compounds is not particularly limited, and substances that can be thermally decomposed at 200 to 450°C may be used, such as aliphatic hydrocarbons, aromatic hydrocarbons, molecules with ether functional groups, molecules with ester functional groups, molecules with anhydride functional groups, molecules with carbonate functional groups, molecules

with acryl functional groups, molecules with thioether functional groups, molecules with isocyanate functional groups, molecules with isocyanurate functional groups, molecules with sulfone functional groups, and molecules with sulfoxide functional groups. The above organic molecules and organic polymers may also include alkoxy silane functional groups, which can react with organosilicate, at the molecular termini or within the polymer. Organic polymers and dendrimers can be either added to the membrane-forming preparation after the production of the organosilicate polymer or added at the time of organosilicate polymer production.

Limited amounts of other additives suitable to the objective, such as colloidal silica, aerosols, geosols and surfactants, can also be added to the membrane-formation preparation obtained through this invention.

The total concentration of solids in the preparation of the present invention is between 2 and 60 wt%; with regard to stability over time and the thickness of the dielectric membrane, it is preferable that this should be between 5 and 40 wt%. The concentration of solids can be controlled through the aforementioned quantity of organic solvent.

The dielectric membrane is formed through coating of the base material of the invention, such as silicon wafer, SiO₂ wafer, SiN wafer, or compound semiconductor. The dielectric membrane may be formed through using spin-coating, roll-coating, spray, or immersion; these methods can be used to

obtain a membrane of a specific thickness. Of these methods, spin-coating is suitable if the objective is to produce an interlayer dielectric membrane for a multilayer circuit of a semiconductor device.

The thickness of the membrane can be adjusted by changing the viscosity of the preparation and the rotating speed of the spin coater; if it is being used for an interlayer dielectric membrane of a multilayer circuit structure for a semiconductor device, ordinarily a thickness between 0.2 and 2 μm is suitable.

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After coating, an organosilicate polymer dielectric membrane having a 3-dimensional structure can be formed through the drying process and shaping (hardening) process. The drying process ordinarily includes both the pre-bake and soft-bake processes. The organic solvent used in the pre-bake process is gradually evaporated, and after a certain quantity of functional groups have been bridged in the soft-bake process, the remaining functional groups are finally reacted in the shaping process. The temperatures at which drying and shaping are carried out are between 30 and 350°C and between 350 and 600°C, respectively; in particular, it is preferable that the shaping be carried out at temperatures between 350 and 500°C. When the shaping temperature reaches 600°C or above, the thermal stability of the organosilicate polymer is reduced; on the other hand, when it is 350°C or below, the condensation polymerization of the organosilicate macromolecule does not occur completely, and the strength of the membrane suffers, and due to the presence of residual functional groups, the dielectric characteristics also deteriorate.

The drying process and shaping process can be carried out through the continuous increase in temperature at a specific rate, or through an intermittent increase. If it is carried out intermittently, the drying and shaping processes should each be carried out over a period of between 1 min and 5 h. Heating can be carried out using a hotplate, oven, furnace, or other method; the heating atmosphere in which the reaction is carried out can be an inert gas atmosphere such as nitrogen, argon, or helium, an oxygen-containing gas atmosphere (such as air), a vacuum, or a gaseous atmosphere containing ammonia or hydrogen. The aforementioned heating methods may be the same for the drying process and the shaping process, or the two processes can use separate methods.

After the drying and shaping processes are complete, surface treatment is carried out as needed, in order to reduce the quantity of hydroxy groups on the interior of the dielectric membrane. The surface-treatment method may use either a silyl compound known in the art such as hexamethylsilazane, alkylchlorosilane, alkylalkoxysilane, or alkylacetoxysilane, or it may be carried out through shaping in the presence of a gas containing fluorine or in a reductive atmosphere such as hydrogen. The silyl treatment method for the dielectric membrane may be carried out by spin coating or immersion in a silyl compound or a silyl compound diluted in solvent, or in a silyl compound vapor atmosphere, and after silyl treatment, it is preferable that the dielectric membrane be heated to between 100 and 400°C.

Because the membrane obtained in this fashion has excellent dielectric properties, membrane uniformity, dielectric constant, internal cracking properties, and membrane surface strength, it is suitable

for use in applications such as interlayer membranes for semiconductor elements such as LSI, system LSI, DRAM, SDRAM, RDRAM, and D-RDRAM, for protective membranes such as surface coatings on semiconductor elements, interlayer dielectric membranes in multilayer circuit boards, and insulating and protective membranes for liquid crystal display elements.

Hereinbelow, the present invention is explained in greater detail through practical and comparison examples. However, the practical examples are provided only to illustrate the present invention, which is not limited thereby.

Practical examples

Practical Example 1

(Production of an Organosilicate Condensate)

13.6 g of methyltrimethoxysilane, 6.78 g of tetraethoxysilane, and 0.55 g of methyldimethoxysilane were added to 25 mL of a tetrahydrofuran solution, cooled to a temperature of 0°C in a nitrogen atmosphere, and mixed sufficiently. After 0.78 mL of 5.0 N hydrochloric acid and 7.74 mL of ultrapure water were slowly added to this mixture, the temperature was slowly increased to 70°C, and reacted overnight by heating while stirring. After dilution in ether following the reaction and washing with water to return the pH to neutral, water was removed from the organic layer thus obtained with a desiccant,

and the organic solvent was removed completely in vacuo, thus obtaining the product in a powdered state.

(Production of a Dielectric Membrane)

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300 mg of the powder obtained above was dissolved in methylisobutylketone to bring the solution to total of 1.5 g. Impurities were removed from the solution thus obtained using a filter, and a membrane was obtained through spin-coating; a dielectric membrane was produced after passing through the drying and hardening processes.

Comparison Example 1

(Production of an Organosilicate Condensate)

13.6 g of methyltrimethoxysilane and 6.78 g of tetraethoxysilane, were added to 25 mL of a tetrahydrofuran solution, cooled to a temperature of 0°C in a nitrogen atmosphere, and mixed sufficiently. After 0.78 mL of 5.0 N hydrochloric acid and 7.74 mL of ultrapure water were slowly added to this mixture, the temperature was slowly increased to 70°C, and reacted overnight by heating while stirring. After the reaction, this was diluted in ether and washed with water until the pH became normal. Water was removed from the organic layer thus obtained with a desiccant, and the organic solvent was removed completely in vacuo, thus obtaining the product in a powdered state.

(Production of a dielectric membrane)

A dielectric membrane was produced from the powder obtained above, in the same manner as in Practical Example 1, passing through the drying and hardening processes.

Comparison Example 2

(Production of an Organosilicate Condensate)

7.5 g of methyltrimethoxysilane and 4.05 mL of ultrapure water were added to 15 mL of tetrahydrofuran solution, the temperature was reduced to 0°C, and the liquid was mixed sufficiently. 0.80 mL of hydrochloric acid with a concentration of 2 N was added slowly to this mixture while stirring. After these had been reacted at room temperature for 30 min, the temperature was gradually increased to 70°C and reacted overnight by heating while stirring. After dilution in ether following the reaction, and washing with water to return the pH to neutral, water was removed from the organic layer thus obtained with a desiccant, and the organic solvent was removed completely in vacuo, thus obtaining the product in a powdered state.

(Production of dielectric membrane)

A dielectric membrane was produced from the powder obtained above, in the same manner as in Practical Example 1, passing through the drying and hardening processes.

(Measurement of Properties)

An MIM(metal/insulator/semiconductor) element was fabricated on a Si wafer, and the dielectric characteristics of the membrane were measured at 1 MHz using an LCR meter from HP.

The mechanical properties of the dielectric membrane were measured after spin-coating onto a 2x2 in Si wafer and hardened for 1 h at 430°C under N₂ conditions.

The elasticity of the dielectric membrane was measured using a TriboIndenter from Hysitron Inc.

The internal cracking characteristics of the membrane were observed through fabricating a /10
membrane with a thickness of 1 μm, inducing cracks, and measuring the rate at which the cracks spread.

The results of the above experiments are shown in Table 1 below.

TABLE 1

Category	Practical Example 1	Comparison Example 1	Comparison Example 2
Dielectric constant	2.71	2.87	2.69
Modulus of elasticity	6.8	6.7	3.0
Crack velocity	$4.8e^{-12}$	$3.4e^{-12}$	$9.4e^{-9}$

As can be seen in Table 1 above, when a membrane is produced from the organosilicate polymer produced in accordance with this invention, the dielectric membrane has high strength, high elasticity, and excellent dielectric properties.

Effect of the invention

When the organosilicate of the present invention is applied to the production of a dielectric membrane, the membrane thus obtained has excellent dielectric properties and elasticity, and also has excellent mechanical characteristics.

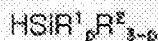
Claims

1. An organosilicate polymer, comprising a) one or more hydride silane compounds as shown in Chemical Formula 1 below, and b) one or more chosen from the group comprising compounds shown in

Chemical Formula 2 below, compounds shown in Chemical Formula 3 below, and compounds shown in

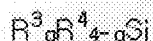
Chemical Formula 4 below:

[Chemical Formula 1]



in Chemical Formula 1 above, R^1 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^2 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; p is a constant from 0 to 2;

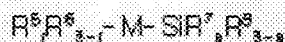
[Chemical Formula 2]



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in Chemical Formula 2 above, R^3 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^4 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; and q is a constant from 0 to 3;

[Chemical Formula 3]



in Chemical Formula 3 above, R^5 and R^7 are each independently a hydrogen, aryl, vinyl, allyl, or a 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with

fluorine; R^6 and R^8 are each independently a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; and r and s are constants from 0 to 2;

[Chemical Formula 4]



in Chemical Formula 4 above, R^9 is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{10} is $-\text{CH}_2-\text{Si}^n(\text{R}^{11})_{3-n}-$, and the R^{11} of R^{10} here is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{12} is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; a is a constant from 1 to 6, and b is a constant from 0 to 2; n and m are each independently constants from 0 to 10.

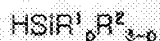
2. The organosilicate polymer recited in Claim 1, wherein the aforementioned a) hydride silane compound is included in a proportion such that the quantity of hydrogen atoms attached to silicon per 1 mol of silicon atoms in all silane compounds is between 0.001 and 0.5 mol.

3. The organosilicate polymer recited in Claim 1, wherein the average molecular weight of the aforementioned polymer is between 500 and 1,000,000. /12

4. A method for producing an organosilicate polymer, comprising a) a stage at which i) 1 or more of the hydride silane compounds shown in Chemical Formula 1 below, together with ii) 1 or more silane compounds chosen from the compounds shown in Chemical Formula 2 below, the compounds shown in

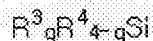
Chemical Formula 3 below, and the compounds shown in Chemical Formula 4 below are mixed together in an organic solvent; and b) a stage at which catalyst and water are added to said mixture and hydrolysis and condensation reactions are carried out:

[Chemical Formula 1]



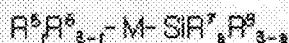
in Chemical Formula 1 above, R^1 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^2 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; p is a constant from 0 to 2;

[Chemical Formula 2]



in Chemical Formula 2 above, R^3 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^4 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; and q is a constant from 0 to 3;

[Chemical Formula 3]



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in Chemical Formula 3 above, R^5 and R^7 are each independently a hydrogen, aryl, vinyl, allyl, or a 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^6 and R^8 are each independently a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; r and s are constants from 0 to 2;

[Chemical Formula 4]



in Chemical Formula 4 above, R^9 is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{10} is $-\text{CH}_2\text{Si}(\text{R}^{11})_2\text{R}^{12}-$, and the R^{11} of R^{10} here is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{12} is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; a is a constant from 1 to 6, and b is a constant from 0 to 2; n and m are each independently constants from 0 to 10.

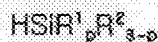
5. The method for producing an organosilicate polymer recited in Claim 4, wherein the aforementioned i) hydride silane compound of the stage a) mixture is included in a proportion such that the quantity of hydrogen atoms attached to silicon per 1 mol of silicon atoms in all silane compounds is between 0.001 and 0.5 mol.

6. The method for producing an organosilicate polymer recited in Claim 4, wherein water is added at a proportion of 0.0001 to 1 mol per 1 mol of total silane compounds subjected to condensation polymerization in stage b).

7. The method for producing an organosilicate polymer recited in Claim 4, wherein water is added /14 at a proportion of 0.1 to 20 mol per 1 mol of silicon atoms among total silane compounds subjected to condensation polymerization in stage b).

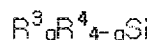
8. A preparation for a dielectric membrane for use in semiconductor elements, including a) i) one or more hydride silane compounds as shown in Chemical Formula 1 below; and ii) an organosilicate polymer derived from the hydrolysis and condensation of one or more silane compounds chosen from the compounds shown in Chemical Formula 2 below, the compounds shown in Chemical Formula 3 below, and the compounds shown in Chemical Formula 4 below; and b) an organic solvent:

[Chemical Formula 1]



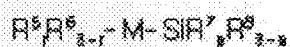
in Chemical Formula 1 above, R^1 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^2 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; p is a constant from 0 to 2;

[Chemical Formula 2]



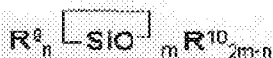
in Chemical Formula 2 above, R^3 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^4 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; and q is a constant from 0 to 3;

[Chemical Formula 3]



in Chemical Formula 3 above, R^5 and R^7 are each independently a hydrogen, aryl, vinyl, allyl, or a 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^6 and R^8 are each independently a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; r and s are constants from 0 to 2; /15

[Chemical Formula 4]



in Chemical Formula 4 above, R^9 is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{10} is $\begin{matrix} CH_2 & SR^{11} & R^{12} \\ | & | & | \\ -CH_2- & -CH_2- & -CH_2- \end{matrix}$, and the R^{11} of R^{10} here is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^{12} is a chlorine, acetoxy, hydroxy,

or a 1 to 4 carbon alkoxy having either a straight or branched chain; a is a constant from 1 to 6, and b is a constant from 0 to 2; n and m are each independently constants from 0 to 10.

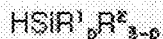
9. The preparation for use in a dielectric membrane for use in semiconductor elements recited in Claim 8, wherein said preparation further includes one or more types of additives chosen from the group comprising c) organic molecules, organic polymers, organic dendrimers, colloidal silica, aerosols, geosols, and surfactants.

10. The preparation for use in a dielectric membrane for use in semiconductor elements recited in either Claim 8 or Claim 9, wherein said preparation has a concentration of solids between 2 and 60 wt%.

11. A method for producing a dielectric membrane for use in semiconductor elements, comprising /16

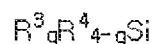
a) a stage wherein a preparation in solution is provided comprising i) α) one or more hydride silane compounds as shown in Chemical Formula 1 above; and β) an organosilicate polymer derived from the hydrolysis and condensation of one or more silane compounds chosen from the compounds shown in Chemical Formula 2, the compounds shown in Chemical Formula 3, and the compounds shown in Chemical Formula 4; and ii) an organic solvent, and if necessary, 1 or more additives chosen from among organic molecules, organic polymers, organic dendrimers, colloidal silica, aerosols, geosols, and surfactants; b) a stage wherein a dielectric membrane is formed by coating the base material of the semiconductor element with the solution from stage a); c) a stage wherein the dielectric membrane formed in stage b) is dried and shaped:

[Chemical Formula 1]



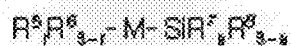
in Chemical Formula 1 above, R^1 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^2 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; p is a constant from 0 to 2;

[Chemical Formula 2]



in Chemical Formula 2 above, R^3 is an aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^4 is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; and q is a constant from 0 to 3;

[Chemical Formula 3]



in Chemical Formula 3 above, R^5 and R^7 are each independently a hydrogen, aryl, vinyl, allyl, or a 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R^6 and R^8 are each independently a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; r and s are constants from 0 to 2;

[Chemical Formula 4]



in Chemical Formula 4 above, R⁹ is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R¹⁰ is $\text{CH}_2\text{---}R^{11}$, and the R¹¹ of R¹⁰ here is a hydrogen, aryl, vinyl, allyl, or 1 to 4 carbon alkyl having either a straight or branched chain and either substituted or not substituted with fluorine; R¹² is a chlorine, acetoxy, hydroxy, or a 1 to 4 carbon alkoxy having either a straight or branched chain; a is a constant from 1 to 6, and b is a constant from 0 to 2; n and m are each independently constants from 0 to 10.

12. The method for producing a dielectric membrane recited in Claim 11, wherein the aforementioned drying of stage b) is carried out at temperatures between 30 and 350°C, and the shaping is carried out at temperatures between 350 and 600°C.

13. A dielectric membrane for use in semiconductor elements, produced through the method presented in Claim 11.

14. A semiconductor element, produced through the method presented in Claim 11.